PA-32674

(54)【発明の名称】　曝気槽の溶存酸素濃度の制御装置

(57)【要約】

【課題】　曝気槽内の溶存酸素濃度を安定化でき、従って流入水質が変化しても安定した処理成績を与えることができるような曝気槽の制御装置及びこれを用いた曝気槽の溶存酸素濃度の制御方法の提供。

【解決手段】　曝気槽に供給される原水の流量計及びその調節弁、返送汚泥流量計、溶存酸素濃度計、曝気槽内圧の圧力検出器、圧力調節弁及び圧力制御調節計、酸素供給量調節弁及びその測定器、入力されたプロセスデータに基づき溶存酸素濃度の長期予測を行い、その目標値を計算するニューラル・ネット・オプティマイザー、溶存酸素濃度の短期予測機能付PID制御装置、及び酸素供給量調節計を備えてなる排水処理用の曝気槽の溶存酸素濃度の制御装置。
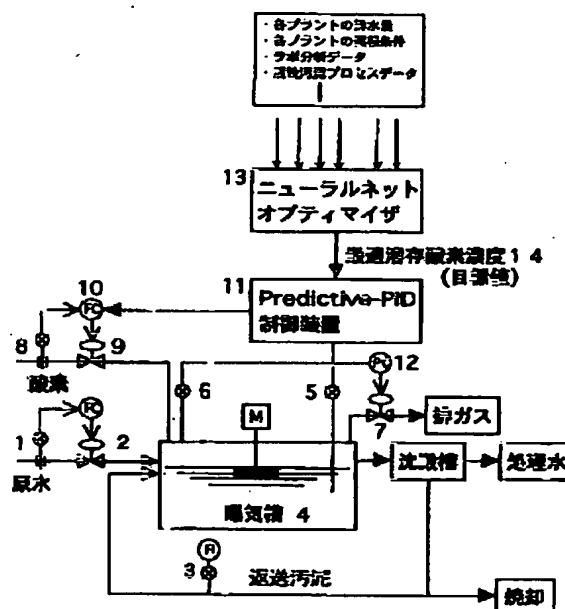
【特許請求の範囲】
【請求項1】 酸素供給配管、原水供給配管、返送汚泥受入配管、排気配管、及び処理水・汚泥の沈殿槽への排出配管を備えた排水処理用の曝気槽（4）の溶存酸素濃度の制御装置であって、以下の計装機器を備えてなる制御装置。
ａ）曝気槽に供給される原水の流量を計測する原水流量計（1）及び原水流量調節弁（2）
ｂ）沈殿槽から返送される汚泥流量を計測する返送汚泥流量計（3）
ｃ）曝気槽内の溶存酸素濃度を測定する溶存酸素濃度計（5）
ｄ）曝気槽の内圧を計測する圧力検出器（6）
ｅ）曝気槽の内圧を調節するために曝気槽の排気配管に設けられた圧力調節弁（7）及び圧力制御調節計（12）
ｆ）曝気槽に供給する酸素量を調節する酸素供給量調節弁（9）
ｇ）酸素供給配管の酸素供給量調節弁（9）の直近に設置された酸素供給量測定器（8）
ｈ）予め定めたプロセスデータを入力することにより、溶存酸素濃度の長期予測を行い、溶存酸素濃度の目標値を算出するニューラル・ネット・オプティマイザー（13）
ｉ）溶存酸素濃度計の計測結果及びニューラル・ネット・オプティマイザーが算出した溶存酸素濃度の目標値に基づいて供給すべき酸素量を算出する短期予測機能付ＰＩＤ制御装置（11）
ｊ）酸素供給量測定器（8）の計測結果と、短期予測機能付ＰＩＤ制御装置（11）の指示した供給すべき酸素量とに基づいて酸素供給量調節弁（9）を調節する酸素供給量調節計（10）
【請求項2】 短期予測機能付ＰＩＤ制御装置の予測モデルとして、酸素供給量に対する溶存酸素濃度の動特性とノイズを考慮に入れた離散線形モデルを用いる請求項1に記載の曝気槽の溶存酸素濃度の制御装置。
【請求項3】 プロセスデータとして、原水の温度、流量、水素イオン濃度（ｐＨ）、化学的酸素要求量（ＣＯＤ）、生物化学的酸素要求量（ＢＯＤ５）、懸濁物質（ＳＳ）、曝気槽の温度、圧力、溶存酸素濃度、槽内混合液懸濁物質（ＭＬＳＳ）、槽内混合液揮発性懸濁物質（ＭＬＶＳＳ）からなる群から選ばれる少なくとも1種以上のデータを使用する請求項1～3のいずれか1項に記載の曝気槽の溶存酸素濃度の制御装置。
【請求項4】 請求項1～3のいずれか1項に記載の溶存酸素濃度制御装置を用いる曝気槽の溶存酸素濃度制御方法。
【請求項5】 供給する酸素として、純度50％以上の酸素を用いる請求項3に記載の曝気槽の溶存酸素濃度の制御方法。

【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、化学工場等の総合排水処理場及び下水処理場等で用いられている活性汚泥法の曝気槽における溶存酸素濃度の制御装置及び制御方法に関するものである。
【０００２】
【従来の技術】活性汚泥法による排水処理プロセスにおいては、曝気槽中で有機物を酸化・分解し、必要に応じ汚泥を凝集した後、沈殿池にて沈降分離し、処理水を得る方法が一般的である。特に、化学工場等の高負荷排水の処理には密閉型の曝気槽を用いる例が多い。
【０００３】この処理において、曝気槽への酸素供給は、通常、原水中和槽や第一沈殿槽等からの前処理設備から供給される原水の流量を測定し、これに基づいて曝気槽内の圧力が一定となるように酸素供給量を調節し、槽内で攪拌することによって水中に酸素を溶解させて行われている。また、曝気槽内の酸素量の適正範囲内への調整は、曝気槽内の気相部の酸素濃度に応じて、排気配管の排出弁を調節して排ガスを系外へ排出することにより行われている。
【０００４】しかし、このような酸素供給を曝気槽の内圧と酸素濃度とに基づいて調節すると、「曝気槽気相部酸素濃度低下→曝気槽圧力調節弁開→槽内圧力低下→酸素供給量調節弁開→酸素供給→槽内酸素濃度上昇→曝気槽圧力調節弁閉→槽内圧力上昇→酸素供給量調節弁閉→酸素濃度低下」のサイクルを繰り返すことになり、制御が安定せず、従って曝気槽内の溶存酸素濃度は安定しない。また、供給される原水の水質を無視しているため、処理成績も不安定であった。
【０００５】
【発明が解決しようとする課題】曝気槽内の溶存酸素濃度を安定化でき、従って流入水質が変化しても安定した処理成績を与えることができるような曝気槽の制御装置及びこれを用いた曝気槽の溶存酸素濃度の制御方法の提供。
【０００６】
【課題を解決するための手段】本発明の要旨は、酸素供給配管、原水供給配管、返送汚泥受入配管、排気配管、及び処理水・汚泥の沈殿槽への排出配管を備えた排水処理用の曝気槽（4）の溶存酸素濃度の制御装置であって、以下の計装機器を備えてなる制御装置、に存する。
【０００７】ａ）曝気槽に供給される原水の流量を計測する原水流量計（1）及び原水流量調節弁（2）
ｂ）沈殿槽から返送される汚泥流量を計測する返送汚泥流量計（3）
ｃ）曝気槽内の溶存酸素濃度を測定する溶存酸素濃度計（5）
ｄ）曝気槽の内圧を計測する圧力検出器（6）
ｅ）曝気槽の内圧を調節するために曝気槽の排気配管に

設けられた圧力調節弁（7）及び圧力制御調節計（1
2）
ｆ）曝気槽に供給する酸素量を調節する酸素供給量調節
弁（9）
ｇ）酸素供給配管の酸素供給量調節弁（9）の直近に設
置された酸素供給量測定器（8）
ｈ）予め定めたプロセスデータを入力することにより、
溶存酸素濃度の長期予測を行い、溶存酸素濃度の目標値
を算出するニューラル・ネット・オプティマイザー（1
3）
ｉ）溶存酸素濃度計の計測結果及びニューラル・ネット
・オプティマイザーが算出した溶存酸素濃度の目標値に
基づいて供給すべき酸素量を算出する短期予測機能付Ｐ
ＩＤ制御装置（11）
ｊ）酸素供給量測定器（8）の計測結果と、短期予測機
能付ＰＩＤ制御装置（11）の指示した供給すべき酸素
量とに基づいて酸素供給量調節弁（9）を調節する酸素
供給量調節計（10）
【0008】また、本発明の要旨は、短期予測機能付Ｐ
ＩＤ制御装置の予測モデルとして、酸素供給量に対する
溶存酸素濃度の動特性とノイズを考慮に入れた離散線形
モデルを用いる上記の曝気槽の溶存酸素濃度の制御装置
にも存し、プロセスデータとして、原水の温度、流量、
水素イオン濃度（ｐＨ）、化学的酸素要求量（ＣＯ
Ｄ）、生物化学的酸素要求量（ＢＯＤ5）、懸濁物質
（ＳＳ）、曝気槽の温度、圧力、溶存酸素濃度、槽内混
合液懸濁物質（ＭＬＳＳ）、槽内混合液揮発性懸濁物質
（ＭＬＶＳＳ）からなる群から選ばれる少なくとも1種
以上のデータを使用する前記の曝気槽の溶存酸素濃度の
制御装置にも存している。
【0009】本発明のもう一つの要旨は上に記した溶存
酸素濃度制御装置を用いる曝気槽の溶存酸素濃度の制御
方法、及び供給する酸素として純度50％以上の酸素を
用いる前記の曝気槽の溶存酸素濃度の制御方法、にも存
する。
【0010】
【発明の実施の形態】以下、本発明について更に詳細に
説明する。本発明の制御装置は、長期的な、多変数・非
線形の予測最適化計算により求めた曝気槽の目標溶存酸
素濃度を、短期的な線形予測制御の目標値として用いて
曝気槽内の必要酸素量を算出し、これに基づいて酸素の
供給量を調節するものであり、これを用いることにより
酸素の過剰な供給を予防しつつ、非定常的な変動要因や
プロセス外乱からくる時間的な変動が生じても安定した
水処理を行うものである。
【0011】本発明の制御装置に用いるニューラル・ネ
ット・オプティマイザーは、過去の運転時のプロセスデ
ータと溶存酸素濃度との関係を予め学習させておき、こ
れに基づいて運転中のプロセスデータから酸素消費量、
排水処理量、排水水質等に関連するコスト関数を最適化

できるような溶存酸素濃度の目標値を算出し、これを短
期予測機能付きＰＩＤ制御装置(Predictive PID Contro
ller)へ出力するものである。ここで本発明の装置のニ
ューラル・ネット・オプティマイザーにおいて入力すべ
き変数であるプロセスデータとしては、原水の温度、流
量、水素イオン濃度（ｐＨ）、化学的酸素要求量（ＣＯ
Ｄ）、生物化学的酸素要求量（ＢＯＤ5）、懸濁物質
（ＳＳ）、曝気槽の温度、圧力、溶存酸素濃度、槽内混
合液懸濁物質（ＭＬＳＳ）、槽内混合液揮発性懸濁物質
（ＭＬＶＳＳ）からなる群から選ばれる少なくとも1種
以上のデータを用いるのが好ましい。これらのデータ
は、それぞれの上限・下限の制約値を併せて予め入力し
ておくのが良い。
【0012】なお、これらのプロセスデータは常法によ
り或いはＪＩＳ　Ｋ　0102等に基づいて測定するこ
とができる。また、例えば化学工場の集中排水処理設備
のように、複数のプラントからの排水を処理する設備に
おいては、それぞれのプラントからの排水を、個別に流
量、ｐＨ、ＣＯＤ等を測定するのが好適である。入力す
べきプロセスデータは上記のものに限られるものではな
い。
【0013】本発明の装置に用いるニューラル・ネット
・オプティマイザーは、入力層、中間層、及び出力層を
有する3階層構造のものが好適である。階層が2階層で
は非線形モデルを扱うことができず、一方4階層構造以
上になると、複雑になりすぎてモデルの「トレーニン
グ」に時間がかかりすぎて実用性が低下する傾向とな
る。
【0014】また、本発明の装置においては、ニューラ
ル・ネット・オプティマイザーにより、前記した種々の
プロセスデータから、各変数の上下限の制約及びコスト
関数を考慮して、溶存酸素濃度の、例えば1〜5日先等
の長期的な応答を予測することにより、コストの最適化
が可能な溶存酸素濃度の目標値を短期予測機能付きＰ
Ｉ Ｄ制御装置に与えることができる。
【0015】本発明に用いる短期予測機能付きＰＩＤ制
御装置は、通常のＰＩＤ制御装置に短期的なモデル予測
機能を持たせたものである。具体的には、過去の溶存酸
素濃度とその目標値との関係を示す運転データ及び酸素
供給量の設定値を用いて、制御対象の線形モデルを使っ
て溶存酸素濃度の将来の推移を計算するというものであ
る。制御対象の線形モデルとしては、酸素供給量に対す
る溶存酸素濃度の動特性とノイズを考慮に入れた離散線
形モデル（ＡＲＩＭＡＸモデル）を用いるのが好まし
い。なお、ＡＲＩＭＡＸモデルとは「Auto Regressive
Integrated Mov-ing Average eXogenous モデル」（自
己回帰積分移動平均外生変数モデル）のことである。
【0016】本発明の装置においては、このような短期
予測機能付きＰＩＤ制御装置により、溶存酸素濃度計か
ら取り入れた信号及び上記の線形モデルを用いて予測さ

れた、少なくとも３～８時間先の溶存酸素濃度の予測値と前述のニューラル・ネット・オプティマイザーで指示される溶存酸素濃度の目標値とを比較し、その偏差が小さくなるように酸素の供給量を調節することにより、溶存酸素濃度を制御するものである。

【００１７】この短期予測機能付きＰＩＤ制御装置には制御対象である溶存酸素濃度の動特性を近似することができる統計モデルを内蔵させることができるので、むだ時間が長くかつ変化するプロセスや、制御対象の時定数が長いプロセスなどに対しても良好な制御性能を示す。また、ノイズモデルを考慮することにより、プロセス外乱に対してもモデルのパラメータ値を調整することなく良好な制御性能を維持することが可能となる。

【００１８】なお、この短期予測機能付きＰＩＤ制御装置に溶存酸素濃度の信号を発する溶存酸素濃度計は曝気槽から汚泥及び処理水が流出する出口付近に設置するのが、実際の処理状況を的確に把握する上で好ましい。本発明方法は、上述の制御装置を用いて、前述のように、好ましくは密閉型の曝気槽の溶存酸素濃度を制御するというものである。

【００１９】酸素の供給量は、上記の短期予測機能付きＰＩＤ制御装置の出力により、酸素供給量調節計の流量設定値を自動的に変更し、その設定値と酸素供給量検出器との流量を比較して酸素供給量調節弁を制御することにより行うことができる。なお、本発明の方法において用いる酸素は純度が高いものが処理効率及び制御の応答性の点から好ましい。その純度としては、酸素含量５０％以上、好ましくは７０％以上、より好ましくは９０％以上、更に好ましくは９５％以上のものが好適である。本発明の制御装置及び制御方法を適用する曝気槽としては、供給する酸素の効率的活用の点から、密閉型の曝気槽が好適である。

【００２０】
【実施例】以下、実施例を用いて本発明の実施の態様をより詳細に説明するが、本発明はその要旨を越えない限り、実施例によって限定されるものではない。図１は密閉型の曝気槽（４）と、これに流入する原水の流量を計測する原水流量計（１）とその流量調節弁（２）、沈殿槽から返送される汚泥の流量を計測する返送汚泥流量計（３）、曝気槽内の溶存酸素濃度を測定する溶存酸素濃度計（５）、曝気槽の内圧を計測する圧力検出器（６）、曝気槽の排気配管に設けられた圧力調整弁（７）及び圧力制御調節計（１２）、曝気槽に供給する酸素の流量を調節する酸素供給量調節弁（９）、酸素供給量調節弁の直近に設けられた酸素供給量測定器（８）、原水の温度、流量、水素イオン濃度（ｐＨ）及び化学的酸素要求量（ＣＯＤ）、生物化学的酸素要求量（ＢＯＤ５）、懸濁物質（ＳＳ）、曝気槽の温度、圧力、溶存酸素濃度、槽内混合液懸濁物質（ＭＬＳＳ）、

槽内混合液揮発性懸濁物質（ＭＬＶＳＳ）のデータに基づいて溶存酸素濃度の目標値を算出するニューラル・ネット・オプティマイザー（１３）、溶存酸素濃度計の計測結果とニューラル・ネット・オプティマイザーにより算出された溶存酸素濃度も目標値とに基づいて供給すべき酸素量を算出する短期予測機能付きＰＩＤ制御装置（１１）、及び酸素供給量測定器の計測結果と、前記予測機能付きＰＩＤ制御装置の指示した酸素量とに基づいて酸素供給量調節弁を調節する酸素供給量調節計からなる曝気槽の溶存酸素濃度制御装置とを示している。

【００２１】この制御装置を用いる曝気槽の溶存酸素濃度制御方法は、曝気槽内の溶存酸素濃度計（５）の計測結果を短期予測機能付きＰＩＤ制御装置（１１）に取り入れ、これと前述のようにしてニューラル・ネット・オプティマイザーにより算出された溶存酸素濃度の目標値との差を比較して目標溶存酸素濃度により近づけられるような酸素供給量を計算し、その結果を酸素供給量調節計（１０）に出力し、酸素供給量測定器（８）の計測結果と比較して酸素供給量調節弁（９）を操作して、酸素供給量を制御するとともに、引き続いて曝気槽の圧力調節計（１２）により圧力調節弁（７）を操作し、曝気槽（４）内のガスを所定圧力まで排出する、というものである。

【００２２】
【発明の効果】本発明の制御装置を用いることにより、曝気槽内の溶存酸素濃度を予測制御することが可能となり、溶存酸素濃度を安定させることができるので、処理水の水質も安定する。また、短期予測と長期予測とを組み合わせることで、上記の動的な制御だけでなく、ニューラル・ネット・オプティマイザーによるコスト・ミニマムとする制御が同時に可能となる。
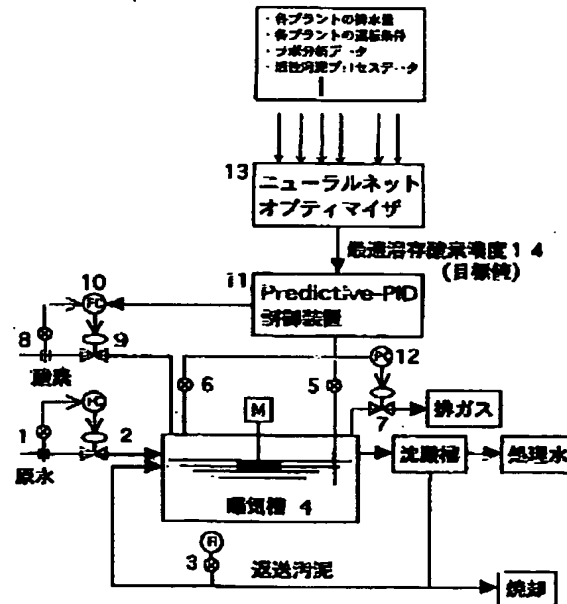
【図面の簡単な説明】
【図１】　本発明の曝気槽の溶存酸素濃度の制御装置の構成の一例を示す概要図である。
【符号の説明】
１・・・原水流量計
２・・・原水流量調節弁
３・・・返送汚泥流量計
４・・・曝気槽
５・・・溶存酸素濃度計
６・・・圧力検出器
７・・・圧力調節弁
８・・・酸素供給量測定器
９・・・酸素供給量調節弁
１０・・・酸素供給量調節計
１１・・・予測機能付きＰＩＤ制御装置
１２・・・圧力制御調節計
１３・・・ニューラル・ネット・オプティマイザー

【図1】

フロントページの続き

(72)発明者　糸山　和年
　　　　　岡山県倉敷市潮通三丁目10番地　三菱化学
　　　　　株式会社水島事業所内

(72)発明者　山本　義章
　　　　　岡山県倉敷市潮通三丁目10番地　三菱化学
　　　　　株式会社水島事業所内
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　　　　　　　　　　　　CD01 CD08 CE03
　　　　　　　　4D029　AA09 AB05 BB10 CC02

Partial English translation of JP-A-2002-219481 (Ref.8)

(page 2, left column, lines 1 to 50)

[Title]

Equipment for controlling a concentration of dissolved oxygen in an aerating tank

[Claims]

1.   Equipment for controlling the concentration of dissolved oxygen in an aerating tank for treating wastewater, including an oxygen feeding pipe, a raw water feeding pipe, a return sludge receiving pipe, an air exhausting pipe, and a pipe for discharging treated water and sludge into a settling tank, comprising:
        a flowmeter of raw water for measuring the flow rate of raw water fed in the aeration tank, and a flow rate control valve of raw water;
        a flowmeter of return sludge for measuring the flow rate of the sludge returned from the settling tank;
        a dissolved oxygen analyzer for measuring the dissolved oxygen concentration in the aerating tank;
        a pressure sensor for measuring the inner pressure of the aerating tank;
        a pressure control valve and a pressure controller provided to the air exhausting pipe of the aerating pipe in order to control the inner pressure of the aerating tank;
        an oxygen feed rate control valve for controlling oxygen rate fed to the aerating tank;
        an oxygen feed rate measuring instrument disposed at the immediate vicinity of the oxygen feed rate control valve of the oxygen feeding pipe;
        a neural net optimizer for predicting the concentration of dissolved oxygen over the long term based on predetermined input process data and calculating the target value of the concentration of dissolved oxygen;
        a short term predictive PID controller for calculating the oxygen rate to be fed based on the measured result of the dissolved oxygen analyzer and the target value of the concentration of dissolved oxygen calculated by the neural net optimizer; and
        an oxygen feed rate controller for controlling the oxygen feed rate control valve based the measured result of

the oxygen feed rate measuring instrument and the oxygen rate to be fed indicated by the short term predictive PID controller.

2.   The equipment for controlling the concentration of dissolved oxygen in an aerating tank according to claim 1, wherein as a prediction model of the short term predictive PID controller, a discrete linear model is used, in which the dynamic characteristics of the dissolved oxygen concentration with respect to the oxygen feed rate and noises are considered.

3.   The equipment for controlling the concentration of dissolved oxygen in an aerating tank according to anyone of claims 1 to 3, wherein as the process data, at least one kinds of data selected from a group composed of the temperature, the flow rate, the hydrogen ion concentration (pH), the chemical oxygen demand (COD), the biochemical oxygen demand (BOD), and the suspended solids (SS) of the raw water, and the temperature, the pressure, and the dissolved oxygen concentration of the aeration tank, the mixed liquor suspended solids (MLSS) in the tank, and the mixed liquor volatile suspended solids in the tank, are used.

4.   A method for controlling   the concentration of dissolved oxygen in an aerating tank using   the equipment for controlling the concentration of dissolved oxygen according to anyone of claims 1 to 3.

5.   The method for controlling   the concentration of dissolved oxygen in an aerating tank according to claim 3, wherein as oxygen to be fed, oxygen having purity being equal to or greater than 50% is used.

EQUIPMENT FOR CONTROLLING CONCENTRATION OF DISSOLVED OXYGEN IN AERATING TANK

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3 1434 ®

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Inventor: RANDY MARVIN MILLER; UDA AKIHITO; ITOYAMA KAZUTOSHI; YAMAMOTO YOSHIAKI

Applicant: MITSUBISHI CHEM CORP

Classification:

- International: *C02F3/12; C02F3/26;* C02F3/12; C02F3/26; (IPC1-7): C02F3/12; C02F3/26

- European:

**Application number:** JP19960193581 19960723

Priority number(s): JP19960193581 19960723

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Abstract of **JP2002219481**

PROBLEM TO BE SOLVED: To provide equipment for controlling an aerating tank which can stabilize the concentration of dissolved oxygen in the aerating tank to provide stable treatment performance even if the quality of inflowing water changes, and a method for controlling the dissolved oxygen in the aerating tank using this equipment.
SOLUTION: This equipment for controlling the concentration of dissolved oxygen in the aerating tank for treating wastewater includes a flowmeter and control valve for the raw water fed to the aerating tank, a return sludge flowmeter, a dissolved oxygen analyzer, a pressure sensor for the pressure in the aerating tank, a pressure control valve and pressure controller, an oxygen feed rate control valve and measuring instrument, a neural net optimizer for predicting the concentration of dissolved oxygen over the long term based on input process data and calculating the target value, a short term predictive PID controller for the concentration of the dissolved oxygen, and an oxygen feed rate controller.
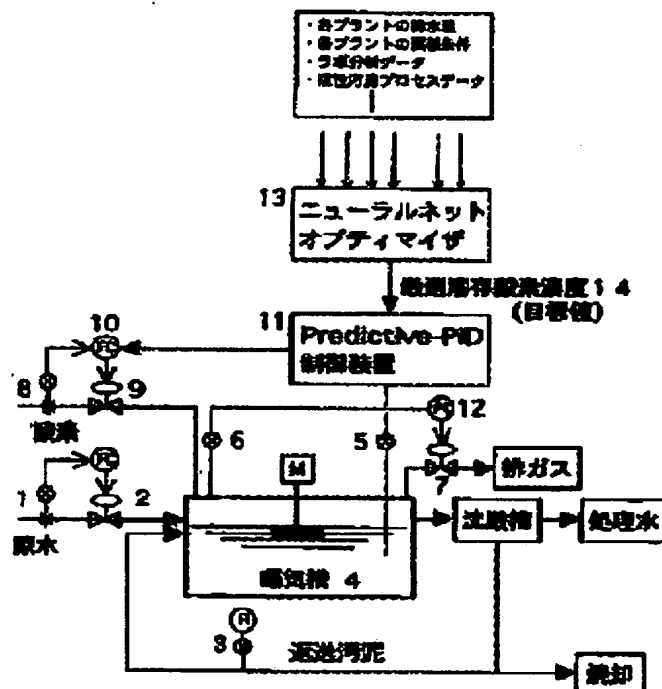
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CLAIMS

[Claim(s)]
[Claim 1] The control unit which is a control unit of the dissolved oxygen concentration of
the aerator equipped with oxygen supply piping, a raw water charging line, a returned sludge
unloading and filling pipe, an exhaust pipe arrangement, and discharge piping to the setting
tank of treated water and sludge for waste water treatment (4), and comes to have the
following instruments.
a) The raw water flowmeter (1) and raw water flow control valve (2) which measure the flow
rate of the raw water supplied to an aerator
b) The returned sludge flowmeter which measures the sludge flow rate returned from a
setting tank (3)
c) The dissolved oxygen concentration meter which measures the dissolved oxygen
concentration in an aerator (5)
d) The pressure sensor which measures the internal pressure of an aerator (6)
e) The pressure regulating valve (7) and pressure-control automatic controller (12) which
were prepared in the exhaust pipe arrangement of an aerator in order to adjust the internal
pressure of an aerator
f) The oxygen supply control valve which adjusts the amount of oxygen supplied to an
aerator (9)
g) The oxygen supply measuring instrument installed in the latest of the oxygen supply
control valve (9) of oxygen supply piping (8)
h) The neural network optimizer which performs long-term prediction of dissolved oxygen
concentration, and computes the desired value of dissolved oxygen concentration by
inputting the process data defined beforehand (13)
i) PID-control equipment with a short-term forecast function which computes the amount of
oxygen which should be supplied based on the desired value of the dissolved oxygen
concentration which the measurement result and neural network optimizer of a dissolved
oxygen densimeter computed (11)
j) The oxygen supply automatic controller which adjusts an oxygen supply control valve (9)
based on the measurement result of an oxygen supply measuring instrument (8), and the
amount of oxygen which PID-control equipment with a short-term forecast function (11)
directed, and which should be supplied (10)
[Claim 2] The control device of the dissolved oxygen concentration of the aerator according
to claim 1 using the discrete linear model which took the dynamic characteristics and the
noise of the dissolved oxygen concentration to an oxygen supply into consideration as a
predictive model of PID-control equipment with a short-term forecast function.
[Claim 3] The control unit of the dissolved oxygen concentration of an aerator given in any 1
term of claims 1-3 which use at least one or more sorts of data chosen from the group
which consists of the temperature of the temperature of raw water, a flow rate, hydrogen ion
concentration (pH), chemical oxygen demand (COD), biochemical oxygen demand (BOD5), a
suspended solid (SS), and an aerator, a pressure, dissolved oxygen concentration, a mixed
liquor suspended solid (MLSS) in a tub, and a mixed liquor volatility suspended solid (MLVSS)

in a tub as a process data.
[Claim 4] The dissolved-oxygen-concentration control approach of the aerator using a dissolved-oxygen-concentration control unit given in any 1 term of claims 1-3.
[Claim 5] The control approach of the dissolved oxygen concentration of the aerator according to claim 3 using oxygen of 50% or more of purity as oxygen to supply.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the control unit and the control approach of
dissolved oxygen concentration in the aerator of an activated sludge process used in a
comprehensive waste-water-treatment place, sewage disposal plants, etc., such as a
chemical plant.
[0002]
[Description of the Prior Art] After setting in the waste-water-treatment process by the
activated sludge process, oxidizing and disassembling the organic substance in an aerator
and condensing sludge if needed, the method of sedimenting in a settling basin and obtaining
treated water is common. Processing of heavy load wastewater of a chemical plant etc. has
especially many examples which use the aerator of closed mold.
[0003] In this processing, the oxygen supply to an aerator usually measures the flow rate of
the raw water supplied from the pretreatment facility from a raw water neutralization tank,
the first setting tank, etc., it adjusts an oxygen supply so that the pressure in an aerator may
become fixed based on this, by stirring within a tub, dissolves oxygen underwater and is
performed underwater. Moreover, adjustment to proper within the limits of the amount of
oxygen in an aerator is performed by adjusting the exhaust valve of an exhaust pipe
arrangement and discharging exhaust gas out of a system according to the oxygen density of
the gaseous-phase section in an aerator.
[0004] however -- if such oxygen supply is adjusted based on the internal pressure and the
oxygen density of an aerator -- ″-- aerator gaseous-phase section oxygen density fall ->
aerator pressure regulating valve open -> -- the cycle of oxygen density rise -> aerator
pressure regulating valve close -> tub internal pressure rise -> oxygen supply control valve
close -> oxygen density fall″ will be repeated in a tub internal pressure fall -> oxygen supply
control valve open -> oxygen supply -> tub, and control is not stabilized, therefore the
dissolved oxygen concentration in an aerator is not stabilized. Moreover, since the water
quality of the raw water supplied was disregarded, processing results were also unstable.
[0005]
[Problem(s) to be Solved by the Invention] The control unit of the aerator which can give the
processing results stabilized even if it could stabilize the dissolved oxygen concentration in
an aerator, therefore the quality of influent changed, and offer of the control approach of the
dissolved oxygen concentration of the aerator using this.
[0006]
[Means for Solving the Problem] The summary of this invention is the control unit of the
dissolved oxygen concentration of the aerator equipped with oxygen supply piping, a raw
water charging line, a returned sludge unloading and filling pipe, an exhaust pipe arrangement,
and discharge piping to the setting tank of treated water and sludge for waste water
treatment (4), and consists in the control unit which comes to have the following
instruments.
[0007] a) The raw water flowmeter (1) and raw water flow control valve (2) which measure

the flow rate of the raw water supplied to an aerator
b) The returned sludge flowmeter which measures the sludge flow rate returned from a setting tank (3)
c) The dissolved oxygen concentration meter which measures the dissolved oxygen concentration in an aerator (5)
d) The pressure sensor which measures the internal pressure of an aerator (6)
e) The pressure regulating valve (7) and pressure-control automatic controller (12) which were prepared in the exhaust pipe arrangement of an aerator in order to adjust the internal pressure of an aerator
f) The oxygen supply control valve which adjusts the amount of oxygen supplied to an aerator (9)
g) The oxygen supply measuring instrument installed in the latest of the oxygen supply control valve (9) of oxygen supply piping (8)
h) The neural network optimizer which performs long-term prediction of dissolved oxygen concentration, and computes the desired value of dissolved oxygen concentration by inputting the process data defined beforehand (13)
i) PID-control equipment with a short-term forecast function which computes the amount of oxygen which should be supplied based on the desired value of the dissolved oxygen concentration which the measurement result and neural network optimizer of a dissolved oxygen densimeter computed (11)
j) The oxygen supply automatic controller which adjusts an oxygen supply control valve (9) based on the measurement result of an oxygen supply measuring instrument (8), and the amount of oxygen which PID-control equipment with a short-term forecast function (11) directed, and which should be supplied (10)
[0008] The summary of this invention moreover, as a predictive model of PID-control equipment with a short-term forecast function It consists also in the control device of the dissolved oxygen concentration of the above-mentioned aerator using the discrete linear model which took the dynamic characteristics and the noise of the dissolved oxygen concentration to an oxygen supply into consideration. As a process data The temperature of raw water, a flow rate, hydrogen ion concentration (pH), chemical oxygen demand (COD), Biochemical oxygen demand (BOD5), a suspended solid (SS), the temperature of an aerator, It consists also in the control unit of the dissolved oxygen concentration of the aforementioned aerator which uses at least one or more sorts of data chosen from the group which consists of a pressure, dissolved oxygen concentration, a mixed liquor suspended solid (MLSS) in a tub, and a mixed liquor volatility suspended solid (MLVSS) in a tub.
[0009] Another summary of this invention consists also in the control approach of the dissolved oxygen concentration of the aerator using the dissolved-oxygen-concentration control unit described above, and the control approach of the dissolved oxygen concentration of the aforementioned aerator using oxygen of 50% or more of purity as oxygen to supply.
[0010]
[Embodiment of the Invention] Hereafter, this invention is further explained to a detail. The control unit of this invention computes the amount of need oxygen in an aerator, using the target dissolved oxygen concentration of the aerator for which it asked by long-term several variables and nonlinear prediction optimization count as desired value of short-term linear-prediction control, adjusts the amount of supply of oxygen based on this, and it performs the water treatment stabilized even if the time fluctuation for which it comes from an unsteady fluctuation factor and an unsteady process disturbance arose, preventing superfluous supply of oxygen by using this.
[0011] The neural network optimizer used for the control device of this invention makes the relation between the process data at the time of the past operation, and dissolved oxygen concentration learn beforehand, computes the desired value of the dissolved oxygen concentration which can optimize the cost function relevant to an oxygen demand, the amount of waste water treatment, wastewater water quality, etc. from the process data

under operation based on this, and outputs this to PID-control equipment with a short-term forecast function (Predictive PID Controller). It is desirable to use at least one or more sorts of data chosen from the group which consists of the temperature of the temperature of raw water, a flow rate, hydrogen ion concentration (pH), chemical oxygen demand (COD), biochemical oxygen demand (BOD5), a suspended solid (SS), and an aerator, a pressure, dissolved oxygen concentration, a mixed liquor suspended solid (MLSS) in a tub, and a mixed liquor volatility suspended solid (MLVSS) in a tub as a process data which is the variable which should be inputted in the neural network optimizer of the equipment of this invention here. These data are good to input beforehand the constraint value of each upper limit and minimum collectively.

[0012] in addition, these process datas -- a conventional method -- or JIS K It can measure based on the 0102nd grade. Moreover, it is suitable to measure the wastewater from each plant for a flow rate, pH, COD, etc. according to an individual, for example in the facility which processes the wastewater from two or more plants like an intensive waste-water-treatment facility of a chemical plant. The process data which should be inputted is not restricted to the above-mentioned thing.

[0013] The thing of three layered structures which has an input layer, an interlayer, and an output layer is suitable for the neural network optimizer used for the equipment of this invention. If a hierarchy cannot treat a non-linear model on two hierarchies but it becomes four or more layered structures on the other hand, it will become complicated too much and will become the inclination for "training" of a model to take time amount too much, and for practicality to fall.

[0014] Moreover, in the equipment of this invention, the desired value of the dissolved oxygen concentration which can optimize cost can be given to PID-control equipment with a short-term forecast function in consideration of constraint and the cost function of the bound of each variable from the above mentioned various process datas by the neural network optimizer by predicting the long-term response of one - five-day after etc. of dissolved oxygen concentration.

[0015] The PID-control equipment with a short-term forecast function used for this invention gives a short-term model prediction function to usual PID-control equipment. Specifically, future transition of dissolved oxygen concentration is calculated using the linear model of a controlled system using the set point of the performance data which shows the relation of past dissolved oxygen concentration and desired value, and an oxygen supply. It is desirable to use the discrete linear model (ARIMAX model) which took the dynamic characteristics and the noise of the dissolved oxygen concentration to an oxygen supply into consideration as a linear model of a controlled system. In addition, an ARIMAX model is a "Auto Regressive Integrated Mov-ing Average eXogenous model" (autoregression integral moving-average exogenous-variable model).

[0016] In the equipment of this invention, the desired value of the dissolved oxygen concentration directed by the forecast of dissolved oxygen concentration at least 3 - 8 hours after and the above-mentioned neural network optimizer predicted by such PID-control equipment with a short-term forecast function using the signal and the above-mentioned linear model which were taken in from the dissolved oxygen densimeter is compared, and dissolved oxygen concentration is controlled by adjusting the amount of supply of oxygen so that the deflection may become small.

[0017] Since the statistical model which can approximate the dynamic characteristics of the dissolved oxygen concentration which is a controlled system can be made to build in this PID-control equipment with a short-term forecast function, good controllability ability is shown also to the process which the dead time browning-izes for a long time, the process that the time constant of a controlled system is long, etc. Moreover, it becomes possible by taking a noise model into consideration to maintain good controllability ability, without adjusting the parameter value of a model also to a process disturbance.

[0018] In addition, the dissolved oxygen concentration meter which emits the signal of dissolved oxygen concentration to this PID-control equipment with a short-term forecast

function is desirable when installing near the outlet sludge and treated water flow out of an aerator grasps an actual processing situation exactly. this invention approach controls the dissolved oxygen concentration of the aerator of closed mold preferably as mentioned above using an above-mentioned control unit.

[0019] The amount of supply of oxygen can be performed by changing automatically the flow rate set point of an oxygen supply automatic controller, measuring the flow rate of the set point and oxygen supply detector, and controlling an oxygen supply control valve by the output of above PID-control equipment with a short-term forecast function. In addition, as for the oxygen used in the approach of this invention, what has high purity is desirable from processing effectiveness and the point of the responsibility of control. 95% or more of thing is still more preferably suitable [50% or more of oxygen contents] as the purity 90% or more more preferably 70% or more. As an aerator which applies the control unit and the control approach of this invention, the aerator of the point of an efficient activity of the oxygen to supply to closed mold is suitable.

[0020]

[Example] Hereafter, although the mode of operation of this invention is explained more to a detail using an example, this invention is not limited by the example unless the summary is exceeded. The raw water flowmeter (1) with which drawing 1 measures the aerator (4) of closed mold, and the flow rate of the raw water with which it flows into this, and its flow control valve (2), The returned sludge flowmeter which measures the flow rate of the sludge returned from a setting tank (3), The dissolved oxygen concentration meter (5) which measures the dissolved oxygen concentration in an aerator, the pressure sensor which measures the internal pressure of an aerator (6), The pressure regulating valve (7) and pressure-control automatic controller (12) which were prepared in the exhaust pipe arrangement of an aerator, The oxygen supply measuring instrument formed in the latest of an oxygen supply control valve (9) and an oxygen supply control valve which adjusts the flow rate of the oxygen supplied to an aerator (8), The temperature, the flow rate, hydrogen ion concentration (pH), and chemical oxygen demand (COD) of raw water, Biochemical oxygen demand (BOD5), a suspended solid (SS), the temperature of an aerator, The neural network optimizer which computes the desired value of dissolved oxygen concentration based on the data of a pressure, dissolved oxygen concentration, the mixed liquor suspended solid (MLSS) in a tub, and the mixed liquor volatility suspended solid (MLVSS) in a tub (13), The PID-control equipment with a short-term forecast function which computes the amount of oxygen which should also supply the dissolved oxygen concentration computed by the measurement result and neural network optimizer of a dissolved oxygen densimeter based on desired value (11), And the dissolved-oxygen-concentration control unit of the aerator which consists of an oxygen supply automatic controller which adjusts an oxygen supply control valve based on the measurement result of an oxygen supply measuring instrument and the amount of oxygen which said PID-control equipment with a prediction function directed is shown.

[0021] The dissolved-oxygen-concentration control approach of the aerator using this control unit The measurement result of the dissolved oxygen concentration meter in an aerator (5) is taken in to PID-control equipment with a short-term forecast function (11). An oxygen supply which compares the difference of this and the desired value of the dissolved oxygen concentration computed by the neural network optimizer as mentioned above, and is close brought by target dissolved oxygen concentration is calculated. While outputting the result to an oxygen supply automatic controller (10), operating an oxygen supply control valve (9) as compared with the measurement result of an oxygen supply measuring instrument (8) and controlling an oxygen supply A pressure regulating valve (7) is succeedingly operated by the pressure controller (12) of an aerator, and the gas in an aerator (4) is discharged to a predetermined pressure.

[0022]

[Effect of the Invention] Since it can become possible to carry out predictor control of the dissolved oxygen concentration in an aerator by using the control unit of this invention and

dissolved oxygen concentration can be stabilized, the water quality of treated water is also stabilized. Moreover, the control made into the cost minimum not only by the above-mentioned dynamic control but the neural network optimizer by combining a short-term forecast and long-term prediction becomes possible at coincidence.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the schematic diagram showing an example of the configuration of the
control unit of the dissolved oxygen concentration of the aerator of this invention.
[Description of Notations]
1 ... Raw water flowmeter
2 ... Raw water flow control valve
3 ... Returned sludge flowmeter
4 ... Aerator
5 ... Dissolved oxygen concentration meter
6 ... Pressure sensor
7 ... Pressure regulating valve
8 ... Oxygen supply measuring instrument
9 ... Oxygen supply control valve
10 ... Oxygen supply automatic controller
11 ... PID-control equipment with a prediction function
12 ... Pressure-control automatic controller
13 ... Neural network optimizer

[Translation done.]

Fig. 1

【図1】

① quantity of waste water in each plant
② operating conditions in each plant
③ laboratory analytic data
④ active sludage process data

・各プラントの排水量
・各プラントの運転条件
・プボ分析データ
・活性汚泥プロセスデータ

13 ニューラルネット オプティマイザ — neural net optimizer

optimum concentration of dissolved oxygen 14 (target value)

最適溶存酸素濃度 14 (目標値)

11 Predictive-PID 制御装置 — control device

10 FC

8 9

oxygen 酸素

1 FC 2

原水

raw water

6 5

M

12

7 排ガス — exhaust gas

aerating tank 曝気槽 4

淀殿槽 処理水 — treated water

settling tank

3 A 返送汚泥 — return sludge

焼却 — incineration